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ABSTRACT

Researchers are developing automated instructional design systems which guide subject matter experts (SMEs) through the complexities of courseware development. Enabling SMEs to perform many of the authoring activities associated with courseware development has two distinct advantages: (1) costs are contained; and (2) SMEs can make optional use of new technologies. This paper focuses on a research called the Guided Approach to Instructional Design Advising (GAIDA). GAIDA incorporates case-based reasoning in a hypermedia framework in order to convey instructional design expertise to novice courseware developers. The paper reviews the theory and development of GAIDA, including interim results of an extensive evaluation effort. The evaluation of GAIDA revealed that users were confused by a completely open hypermedia tutorial on instructional systems development tested in conjunction with the first GAIDA version; users were able to follow and benefit from the structured hypermedia approach; and controlled studies of novice instructional designers showed that courseware developed using GAIDA was generally effective. (Contains 11 references.) (Author/JLB)

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A GUIDED APPROACH TO INSTRUCTIONAL DESIGN ADVISING

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Abstract: Researchers are developing automated instructional design systems which guide subject matter experts (SMEs) through the complexities of courseware development (Spector, 1993). Enabling SMEs to perform many of the authoring activities associated with courseware development has two distinct advantages: (1) costs are contained, and (2) SMEs can make optimal use of new technologies. This paper will focus on a research effort called the Guided Approach to Instructional Design Advising (GAIDA). GAIDA incorporates case-based reasoning in a hypermedia framework in order to convey instructional design expertise to novice courseware developers. The paper reviews the theory and development of GAIDA, including interim results of an extensive evaluation effort.

As computer-based instruction (CBI, to be interpreted broadly) has matured, automated environments to support instructional design and development have become commercially available. At the same time, computer-based technologies have become richer and more complex with the advent of such advanced interactive technologies as digital audio/video, interactive simulations, and virtual worlds (Spector, 1990).

As a consequence, an organization which has the task of producing CBI must confront two difficult issues: (1) where to obtain the expertise required to produce quality CBI; and (2) how to make it cost-effective to produce a variety of CBI solutions to satisfy various training requirements. There is an industry-wide shortage of instructional technology expertise, which makes a near-term solution to the first issue difficult. Automated tools are expected to provide some support for the second issue. The system described in this paper, Guided Approach to Instructional Design Advising (GAIDA) represents an attempt to respond to both problems (Merrill, Li, & Jones, 1990).

A Theoretical Framework

An attempt to capture instructional design expertise in an automated system must address these two fundamental issues: (1) What distinguishes novices from experts in this particular domain? and (2) What is the purpose of the design advisor? With regard to expert-novice differences, the expectation based on findings in cognitive science is that experts perform complex procedures automatically, without consciously attending to specific steps (Anderson, 1987; Duchastel, 1990). Novices, on the other hand, are inclined to perform complex procedures one step at a time, without looking ahead or considering the overall problem setting. The first issue, then, is to determine if this generalization about novice-expert differences holds true in the domain of instructional design. An extensive study of expert and novice instructional designers indicates that this generalization is indeed true (Rowland, 1992). Moreover, experts tend to proceed from the problem statement (e.g., design instruction to support a particular set of instructional objectives with regard to some content area) to a framework which is likely to be appropriate for the task at hand based on past experience (Rowland, 1992). In other words, experts begin with a case construct that is known to be effective and they then modify that case-based framework to accommodate the particular details of the new task.

Novices, on the other hand, are inclined to follow procedures which are codified in sets of instructions commonly referred to as instructional systems development (ISD). The Department of Defense (DoD) is probably the largest single user of ISD. The Air Force has recently devoted significant resources to updating these procedures to reflect current academic thinking about instructional design (Tennyson, 1993). ISD is

intended to provide instructional design guidelines, among other things. The intent is not to prescribe specific steps to be followed inflexibly no matter what the situation. However, these guidelines are placed in the hands of novice instructional designers who have no other recourse other than following the specific steps specified in the various ISD procedures. The results of instruction designed in these circumstances is not always optimal. When the instruction is computer-based, this process can result in expensive but ineffective courseware. Because the DoD is facing financial and personnel cutbacks, the shortage of instructional design expertise is expected to worsen while requirements for high quality courseware increase.

In response to this situation, Armstrong Laboratory has been studying various means of enhancing the performance of novice courseware developers. The basic premise is that the Air Force cannot afford to contract out the development of the courseware needed to maintain operational proficiency and readiness. Therefore, performance support tools must be provided to enable novice but motivated courseware developers to perform as if they had years of experience. Gagné proposed a relatively simple solution to this problem: Provide novices with easily understood high level guidance along with completely worked examples and they will perform as if they were advanced apprentices (1991). Gagné further proposed that the appropriate high level guidance could be constructed around the nine events of instruction (1985). The completely worked examples should reflect frequently encountered instructional objectives, such as identifying a part of a device or carrying out a test procedure on a device. Figure 1 is a screen from GAIDA which illustrates the nine events of instruction. Figure 2 shows the instructional objectives currently supported in GAIDA.

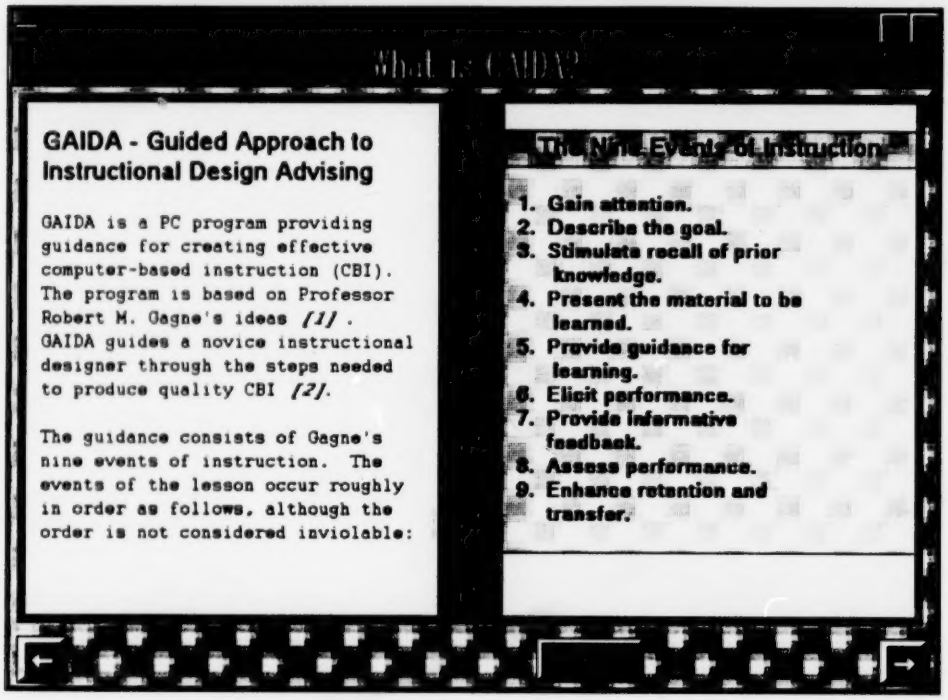
GAIDA - Guided Approach to Instructional Design Advising
GAIDA is a PC program providing guidance for creating effective computer-based instruction (CBI). The program is based on Professor Robert M. Gagne's ideas [1]. GAIDA guides a novice instructional designer through the steps needed to produce quality CBI [2].
The guidance consists of Gagne's nine events of instruction. The events of the lesson occur roughly in order as follows, although the order is not considered inviolable:
1. Gain attention.
2. Describe the goal.
3. Stimulate recall of prior knowledge.
4. Present the material to be learned.
5. Provide guidance for learning.
6. Elicit performance.
7. Provide informative feedback.
8. Assess performance.
9. Enhance retention and transfer.

Figure 1. GAIDA's nine events of instruction.

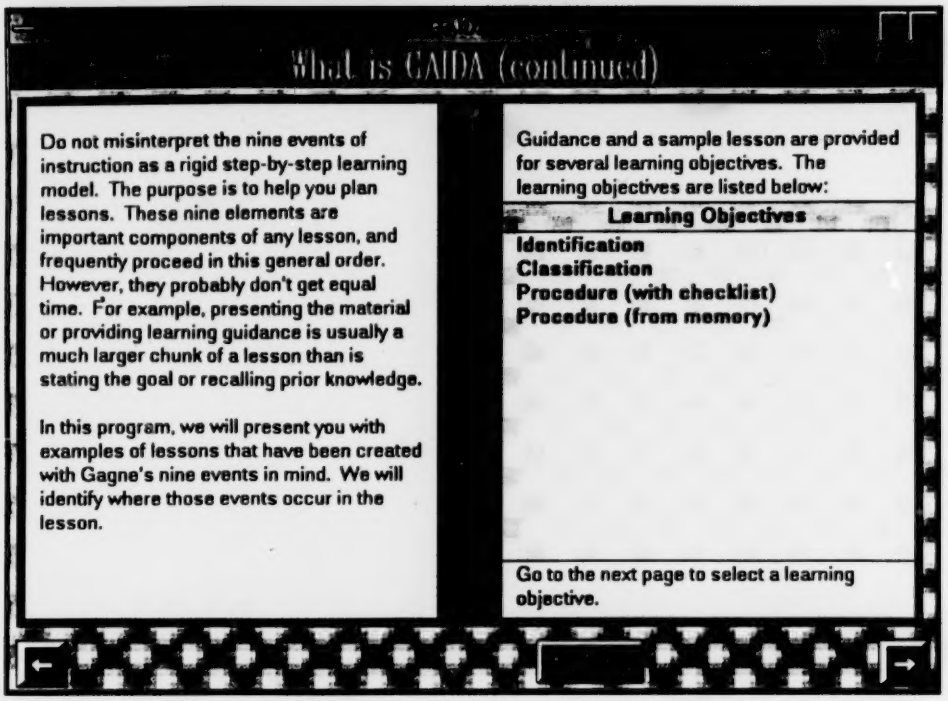
What is GAIDA (continued)
Do not misinterpret the nine events of instruction as a rigid step-by-step learning model. The purpose is to help you plan lessons. These nine elements are important components of any lesson, and frequently proceed in this general order. However, they probably don't get equal time. For example, presenting the material or providing learning guidance is usually a much larger chunk of a lesson than is stating the goal or recalling prior knowledge.
In this program, we will present you with examples of lessons that have been created with Gagne's nine events in mind. We will identify where those events occur in the lesson.
Guidance and a sample lesson are provided for several learning objectives. The learning objectives are listed below:
Learning Objectives
Identification
Classification
Procedure (with checklist)
Procedure (from memory)
Go to the next page to select a learning objective.

Figure 2. GAIDA instructional objectives.

In summary, the theoretical framework for GAIDA is drawn from two sources. From cognitive science, GAIDA proceeds on the assumption that providing novices with on-line examples or cases will make up a significant portion of the difference between novice and expert instructional design performance. From instructional science, GAIDA proceeds on the assumption that elaborating the nine events of instruction will provide an easily understood and meaningful framework for a novice designer (for additional elaboration of integrating theoretical frameworks, see Gagné & Merrill, 1990; see also Spector, Polson, & Muraida, 1993).

Implementation of an Instructional Design Advisor

Armstrong Laboratory decided to test Gagné's hypothesis. Gagné agreed to come to the laboratory as a National Research Council Senior Fellow and design the system that he had proposed. Gagné argued that GAIDA should first attempt to support a difficult design task, such as training students to memorize a complicated procedure. The School of Aerospace Medicine at Brooks Air Force Base provided such a case: a procedure to test a patient's respiratory capacity. Students have to learn how to set up a device called a spirometer, how to connect a patient to the device, what to tell the patient to do, and how to interpret the graph produced by the machine. The sample computer-based lesson and the accompanying design guidance were created under the close supervision of Gagné and a subject matter expert (SME). The original system was coded in Asymetrix' ToolBook (a high level, object-oriented language for the MicroSoft Windows environment on 80386/80486 personal computers). Because GAIDA was itself a piece of instruction, Gagné wanted to include an opportunity for users (novice developers) to practice applying the guidance provided. This necessitated allowing users to create a new ToolBook lesson. This task of providing an opportunity for practice proved to be a distraction. Users were not familiar with ToolBook and were not motivated to learn it since they would be using another authoring language.

The GAIDA design team eventually dropped that requirement, which meant that the subsequent GAIDA version was more like on-line tutorials provided with many software packages. The revised version with a checklist procedure was then tested at an Air Force Technical Training Center with six instructional designers. The results were positive in that all users indicated that the guidance was useful and instructive and could be applied to their design tasks and implemented in the various languages they had available (Gagné, 1992).

Figure 3 depicts the general architecture that has been adopted for GAIDA. Once the user has selected a case thought to be similar to the development task at hand, that lesson is loaded into memory and the elaboration of the nine events continues. The outer window provides a generic explanation of what it means to gain a learner's attention. There is additional guidance for those using multimedia which is provided via the "ICW" (interactive courseware) button. The "notes" button allows users to keep notes that could be used as a draft storyboard. The inner window provides first a generic view of what could be done in this type of lesson and then a textual description of what was done. The user can put the system into case-mode by pressing the "SAMPLE LESSON" button.

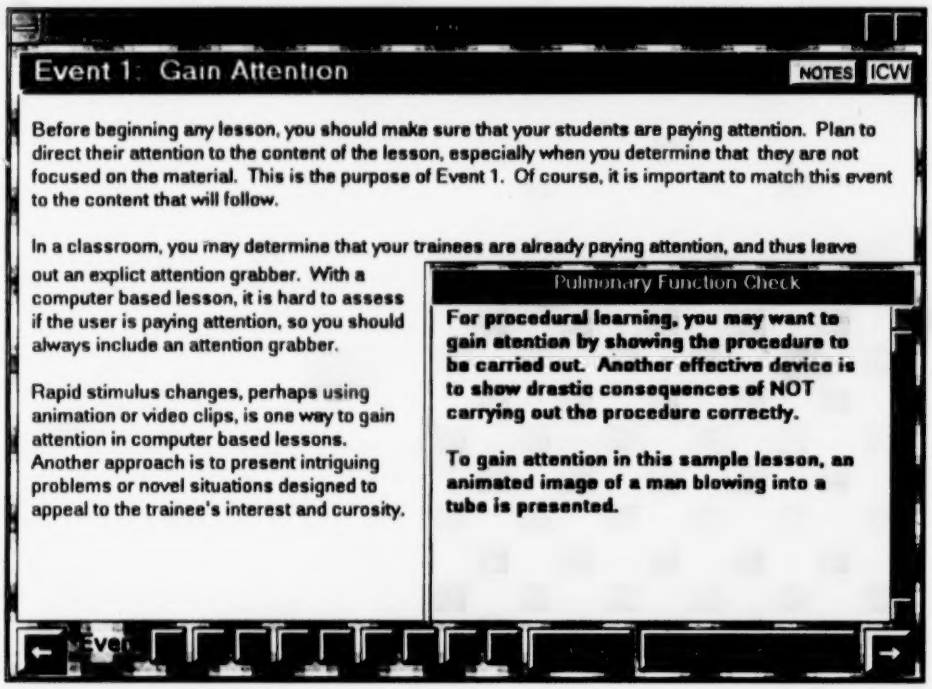
Event 1: Gain Attention
NOTES
ICW
Before beginning any lesson, you should make sure that your students are paying attention. Plan to direct their attention to the content of the lesson, especially when you determine that they are not focused on the material. This is the purpose of Event 1. Of course, it is important to match this event to the content that will follow.
In a classroom, you may determine that your trainees are already paying attention, and thus leave out an explict attention grabber. With a computer based lesson, it is hard to assess if the user is paying attention, so you should always include an attention grabber.
Rapid stimulus changes, perhaps using animation or video clips, is one way to gain attention in computer based lessons. Another approach is to present intriguing problems or novel situations designed to appeal to the trainee's interest and curosity.
Pulmonary Function Check
For procedural learning, you may want to gain atention by showing the procedure to be carried out. Another effective device is to show drastic consequences of NOT carrying out the procedure correctly.
To gain attention in this sample lesson, an animated image of a man blowing into a tube is presented.

Figure 3. GAIDA event elaboration.

Figure 4 depicts the case-mode, which is a part of the actual lesson. GAIDA can be executed entirely in case or lesson mode so that users can view exactly what students see. The expected mode of use is guidance mode, with the opportunity to view the lesson directly as desired. Figure 4 actually shows a text screen from the lesson that comes up after an animated sequence of a patient breathing into the spirometer. One of the hypotheses that we are testing is the utility of providing the on-line capability of switching back and forth between a lesson/student view and a guidance/designer view. Data collected to date from more than 40 users indicate that this mode switching feature is one of the most frequently used features in GAIDA. In fact, it is used more than the note-taking capability which is a bit of a surprise.

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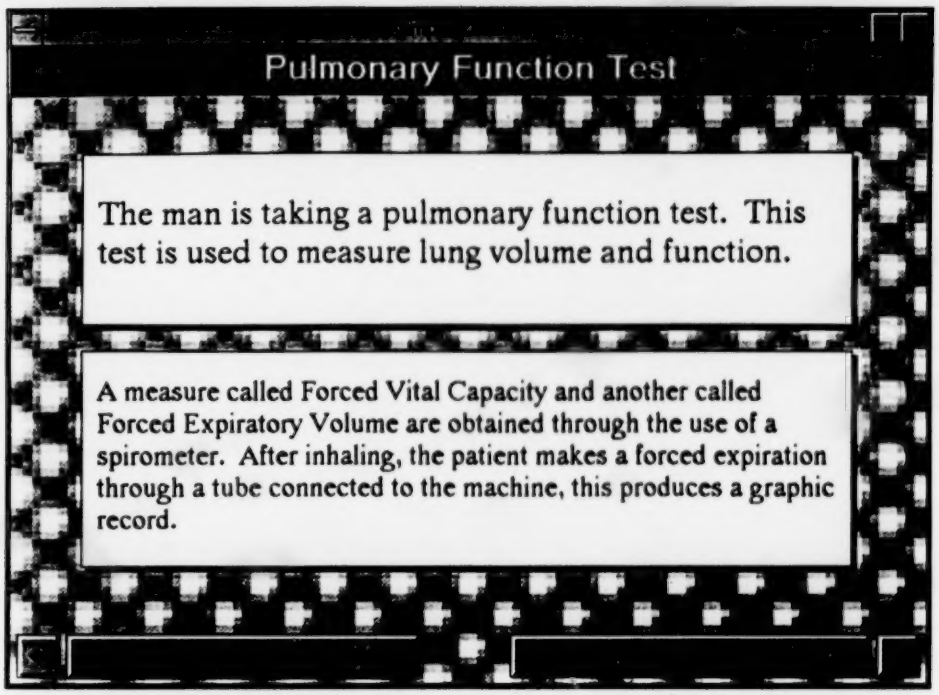
Pulmonary Function Test
The man is taking a pulmonary function test. This test is used to measure lung volume and function.
A measure called Forced Vital Capacity and another called Forced Expiratory Volume are obtained through the use of a spirometer. After inhaling, the patient makes a forced expiration through a tube connected to the machine, this produces a graphic record.

Figure 4. GAIDA case mode (lesson view).

Two additional cases were added after the procedural cases were refined in order to provide a minimum repertoire of cases to support a novice courseware designer (see Figure 2). At this point, the GAIDA architecture has stabilized and GAIDA is now easily extensible. New example cases can be added as they are validated and become available. The guidance which elaborates the nine events and the specific cases can easily be changed to accommodate specific practices at various sites. In short, GAIDA is well positioned to grow into a much more robust on-line design advisor with an elaborate case base. Four additional cases are now under development which will extend GAIDA's domain of applicability into academic subject matter as well as into advanced multimedia (digital audio and video).

Evaluation of an Instructional Design Advisor

The evaluation of GAIDA has revealed a number of interesting findings: (1) users were confused by a completely open hypermedia tutorial on ISD tested in conjunction with the first GAIDA version; (2) users were able to follow and benefit from the structured (restricted movement) hypermedia approached incorporated in GAIDA; (3) controlled studies of novice instructional designers (SMEs in this case) showed that courseware developed using GAIDA's guidance was generally effective and superior to that developed without the benefit of this guidance (Gagné, 1992).

It is worth noting that evaluation of an automated instructional design advisor is somewhat complicated. First, there must be an appropriate set of evaluations for the courseware produced using a performance support tool such as GAIDA. That is to say that the lessons and courses must be instructionally effective and appropriate measures must be established to document this fact. However, the primary focus is not on the instructional intervention between learning environment and learner, as in traditional evaluations. The primary focus is on the intervention between the novice designer and the automated instructional design

tool. These interventions must be evaluated with regard to cost-effectiveness (Did they help novices produce effective instruction in less time than some baseline standard?). The system must also be evaluated with regard to instructional utility (Was the system helpful in creating meaningful interactions for learners and did it help advance the novice into a more expert-like state with regard to instructional design?). These are not simple questions and we do not pretend to have the answers. We can say that our evaluations are continuing so that we can better address such questions.

Conclusions

Our conclusions are that: (1) the content of the revised ISD model is useful; (2) the practice of following that model is time-confusing and stifling; (3) on-line instructional design cases are useful to novice designers; and (4) restricted hypermedia systems are appropriate for introducing novice designers to the complexities of instructional design. We believe that as additional cases are added to the GAIDA case base along with the appropriate instructional commentaries that it will be possible to accelerate the performance of novice courseware developers so that they will perform as advanced apprentices. The potential cost savings of this kind of performance enhancement are enormous.

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